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United States Department of Agriculture | Forest Service | Forest Pest Management | 55 So. Sacramento Street Susanville, CA 96130 530-257-2151 VOICE 530-257-6244 TTY

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Subject: Entomological input to the Booth Project Area, Nevada City RD, Tahoe NF (Report # NE97-14)

To: District Ranger, Nevada City RD, Tahoe NF

At the request of District personnel, I visited several stands in the Booth Project Area (T18N R10E Sec. 12,13,14; T18N R11E Sec. 3,4,5,7,8,18; T19N R11E 26,27,33,34) on October 7, 1997. The objectives of the visit were to review several stands for entomological concerns and provide some management alternatives to reduce/limit bark and engraver beetle-related mortality in the future.

Bark and engraver beetle-related mortality occurs primarily in "groups" of trees with the pine bark beetles, primarily due to their pheromone system, or as single true fir trees scattered over several acres with the fir engraver. Successful attacks by the pine bark beetles (western, mountain and Jeffrey pine beetles) result in tree mortality. Successful attacks by the fir engraver (in red and white fir) can result in top-kill, branch kill, patch kills along the bole and/or whole tree mortality. In general, mortality occurs in overstocked stands; however, during periods of protracted drought, mortality may be expected to occur throughout various stocking regimes. Effects resulting from bark beetles may include the following: direct tree mortality, openings that vary in size, less trees/acre, reduced canopy closure, increase in standing dead and down woody material, increase in fuel load, increase in decomposition and nutrient cycling, increase species diversity/decrease species diversity, increase in snags and cavity nesting opportunities and a change in species composition.

The importance or significance of these effects depends on their severity and extent and ultimately how they affect (positively and/or negatively) ecosystem structure and function (desired condition) and specific management goals and objectives.

Stand 1020 - 62 acres - This is a mixed conifer stand comprised of white fir, Douglas fir, incense cedar, sugar pine and ponderosa pine. This stand is being managed as a protected activity center (PAC) for California spotted owls. Management alternatives should incorporate the need to maintain large trees, snags, and down woody material, and the desire to have a two or multi-storied stand. Current basal area was estimated at 180 sq. ft./acre. The stand density index (SDI) is 224. The main discussion regarding management of this stand centered around the need to provide some level of fire protection for the town of Graniteville and the ability to maintain it as owl habitat at the same time.

Some top kill and whole tree mortality associated with the fir engraver, Scolytis ventralis, has occurred over the past several years in the white fir component. Based on the condition of the standing dead trees and those on the ground, mortality has been occurring in these stands for several years. The mortality pattern did not seem to indicate a large increase of fir engraver activity in a single year, often typical during protracted drought periods. rather, the pattern was typical of a chronic level of bark beetle activity likely associated with the suppressed trees in the understory.

Stand 919 - 121 acres - This stand is also a mixed conifer stand, dominated by ponderosa and sugar pine. White fir, incense cedar and Douglas fir are also components. The current basal area is 258 sq. ft./acre with an SDI of 391. This stand shares a boundary with Stand 1020 and also contains areas managed as a PAC. Part of this stand was burned in the 1987 Graniteville fire.

Agents detected in this stand included white pine blister rust in the sugar pine and fir engraver beetle in the white fir. Snow breakage was also common in several areas of this stand.

Stand 1806 - 40 acres - This is a Douglas fir and white fir dominated mixed conifer stand. Other existing species include ponderosa pine, sugar pine, incense cedar and oaks. The current basal area is 230 sq. ft./acre with an SDI of 347. This stand is part of a PAC for California spotted owls.

This stand has sustained an extreme amount of white fir mortality over the past several years. It is likely that the majority of the mortality occurred during the recent protracted drought period. Drought, overstocked conditions, and fir engraver attacks were the factors associated with the elevated levels of mortality. Many of the dead trees have fallen and are contributing to heavy amounts of fuels. Low levels of current white fir mortality (1997) were also detected.

Stand 1805 - 45 acres - This is a mixed conifer stand dominated by white fir (74%). Sugar pine and incense cedar are other common associates. The current basal area is 170 sq. ft./acre with an SDI of 264. This stand shares a border with 1806 and is completely within a PAC.

There is a low level of white fir mortality which has occurred over the past few years, primarily in the suppressed understory. Currently the amount of mortality has not contributed greatly to fuel loadings. Similar to the other stands, drought, stand conditions and fir engraver attacks were contributing factors in the mortality. Current mortality (1997) was not above background levels.

Discussion

Bark Beetles

Over the past few years, the fir engraver, Scolytus ventralis, has been the most important bark beetle operating in these stands. Under adequate moisture regimes, overstocking of fir stands and high infection rates by root diseases are the principal factors involved in predisposing trees to attack by fir engraver. Populations of less aggressive bark beetle species, like fir

engraver, are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality; however, attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that were once pine dominated sites may also contribute to higher than normal levels of fir mortality. Therefore, on the west side of the Sierra Nevada most fir engraver-related mortality occurs during protracted drought periods when there is an ample supply of host material available over a period of several seasons or in overstocked stands where a chronic level of mortality is apparent even during normal precipitation years.

Many of the larger diameter trees in these stands are the pine species. Although Dendroctonus beetle activity appeared minimal at this time, land managers should be aware that in stands of similar species composition, and age and class structures, high levels of mortality in the overstory pine were quite common during the recent drought in west side stands. This may be of even greater concern in stands that are being managed as PACS where large trees are an important component. Although west side stands are often able to handle higher stocking levels, compared to drier, east side stands; the outcome of trying to carry higher amounts of basal area is often the loss of the ponderosa pine in the overstory. In most of the stands examined during this evaluation the understory is comprised of species that are growing vigorously under the current conditions and perhaps even more important, they are species that are either less susceptible to bark beetle attacks or are attacked by beetles that do not tend to be as aggressive as the Dendroctonus species.

Direct tree mortality as a result of insect attack is not common in incense cedar. The bark beetles, Phloeosinus sp., and wood borers that attack incense cedar are not considered to be aggressive tree killers; however, their impact, combined with drought stress can cause mortality. The Douglas fir that occurs in this area is not often impacted by insects and/or pathogens typical of more coastal areas. Flatheaded fir borer, Melanophila drummondi, and black stain root disease, Leptographium wageneri are commonly associated with decline of Douglas fir; however, the detected incidence of black stain root disease in Douglas-fir in the Sierra Nevada is quite low. Extended drought periods in concert with attacks by the flatheaded fir borer may cause an increased level of Douglas fir mortality.

Soils

Mortality should be expected to be exacerbated in areas where soils tend to be shallow and sandy, particularly during protracted drought periods in overstocked stands. Soil type should be a key factor in determining the appropriate stocking density and desired species mix of the residual trees. Ponderosa pine, a more drought tolerate species, should be favored on drier, droughty sites. Incense cedar is also well adapted to handle dry conditions. Deeper soils would tend to favor incense cedar over more shallow soils. It often grows more slowly than associated conifers and is therefore, typically a component of the intermediate and suppressed crown classes. Although dry, droughty sites may be capable of growing such species as white fir and Douglas-fir, it is not likely that these soils can sustain these species long enough to get them to the larger size classes, particularly

during protracted drought periods. Douglas fir grows better on well drained, deep soils, rather than those that are poorly drained and have an impervious layer near the surface. White fir is found on a variety of soils developed from almost every kind of parent material. It is generally tolerant of a wide range of soil conditions, nutrient availability and pH values. It seems to be more dependent on moisture availability and temperature than on soil series. If maintenance of drought-intolerant species is desired, stocking densities should be adjusted to reflect this. A mix of tree species and ages, maintained within appropriate stocking levels, will likely result in retaining some trees during periods of stress or during periods of elevated bark beetle activity. The ability to meet the objectives for owl habitat in some of these stands should be questioned. It is not likely that, through time, these stands can carry the amount of desired stocking levels in concert with a two story stand structure dominated by large trees. An increase in mortality levels should be expected, particularly during protracted drought periods, if stand conditions are not altered to promote tree health and vigor.

Stand Conditions

The desired state of forest health is the condition where biotic and abiotic influences do not threaten resource management objectives and provide desired, sustainable ecosystems. In part, a healthy forest is one in which the environmental effects of insects and pathogens are maintained within acceptable limits and do not result in unacceptable impacts on the sustainability of the ecosystem structure and function or specific resource management goals and objectives. Dependent upon management objectives, the acceptable level of insect and pathogen-related activity may vary greatly.

A majority of the Booth Project area is comprised of protected activity centers for California spotted owls. Mortality levels, particularly in stand 1806, have decreased the quality of wildlife habitat and increased the potential of losing the habitat to fire. It is apparent from this evaluation that during protracted drought periods elevated levels of mortality should be expected. These sites are capable of growing white fir, as evidenced by a large component of white fir as well as several large white fir trees in the stands. However, the current condition in some stands is evidence that sustaining a high percent of these species on these sites is not likely during protracted drought periods.

Management Alternatives

(1) No action - Overstocked stands in general will tend to have higher levels of bark and engraver beetle-related mortality. The basal areas in stands will continue to increase as the trees grow. Periodic droughts in California increase the probability that some of the overstocked stands will be attacked by bark beetles. Although some mortality may be desired for snags, small openings and for future down woody debris, the no action alternative will most likely result in unacceptable levels of conifer mortality. Mortality levels will typically be above background levels as stand density increases, and this affect will be accentuated during periods of below normal precipitation. In addition, in stands with an overstory component of ponderosa and sugar pine, selection of the no action alternative will likely result in the loss of these

trees to bark beetles and thus, promote an understory of Douglas fir, incense cedar and white fir.

The direct result of an increase in tree mortality is the increase of standing, dead trees and down woody material. This may result in: a continuing desire to enter stands to conduct salvage operations; an increase in fuel loading; fewer large, older trees and fewer of the mid-diameter trees that represent the pool from which the large trees and snags of the future come from; a short term increase in nutrient cycling; and an increase in the number of hazard trees.

(2) Salvage - Salvage sales can minimize the economic loss and reduce the amount of dead fuel; however, these operations will have no effect in reducing or controlling bark beetle populations. At the present time, there are no biologically effective or economically efficient methods available to directly reduce bark and engraver beetle populations on an area-wide basis under current California conditions such that tree mortality will be reduced to acceptable levels. As a general rule, during periods of above normal tree stress, it is recommended that logging, thinning and timber stand improvement work be minimized as much as possible to reduce the potential for additional stress. Where such activities must occur, extra care should be taken to prevent damage to residual trees.

(3) Thinning Overstocked Stands - Depending upon management objectives, some silviculture treatments can enhance or help maintain the coniferous component in the project area. Silvicultural treatments can make the stand's growing space available to desirable species and/or put individual trees in a competitively advantageous position. Thinning stands to a lower basal area while favoring those species that are best adapted to the sites should decrease the amount of future mortality in the Booth project area. Based on wildlife objectives a majority of this thinning would be from below in an effort to retain the larger diameter trees in the overstory. In addition, thinning around large diameter trees will increase the precipitation and nutrients available to them. Through time, thinning should result in lower levels of bark and engraver beetle-related mortality.

Management activities that promote tree health and vigor also reduce the susceptibility to successful bark beetle attack. Increased tree health and vigor is not usually an immediate response. In the short term, thinning stands places an additional stress on the trees, similar to other management activities. Therefore, thinning during non-drought periods would be advocated rather than waiting until mortality is detected. Thinning is perhaps the most critical silvicultural treatment available to restore tree health. Silvicultural prescriptions designed to reduce basal area and select for species and stand structure diversity should result in fewer bark beetle-related impacts in the future. Reduced mortality would also have the effect of a reduction in the occurrence of understocked areas that would have low canopy closure. Mortality would continue to occur and fluctuate in response to the amount of available moisture, but at levels that, through time, would more closely approximate naturally occurring mortality. Thinning would result in: a decrease in the need to enter stands to conduct salvage operations; a decrease in the amount of fuel loading; and a reduction in the number of hazard trees.

Snags, down woody material, and nutrient cycling would occur at more natural levels. The improved growing conditions should result in reduced mortality of large diameter trees and an increase in mid-diameter trees available to grow into large diameter classes. Selecting for some diversity of residual tree species during thinning is desired as bark beetles are fairly host-specific and diversity should guarantee that some trees will remain alive during elevated stress periods.

Conclusion

Implementation of alternatives 2 and 3, combined with vegetation restoration activities in the high mortality areas will most likely result in obtaining and maintaining the management goals and objectives for this area. The reintroduction of fire into some of these stands may also be appropriate. Objectives to be considered may include restoring the resistance and resilience to natural stresses, decreasing the risk of catastrophic fires, and modifying the vegetation to reduce potential damages caused by insects and diseases.

If you have any questions regarding this evaluation or need additional assistance please call me at 530-252-6667.

Sheri Lee Smith
Entomologist
NE CA Shared Service Area

White Pine Blister Rust

Blister rust (Cronartium ribicola) is caused by an obligate parasite that attacks sugar and western white pines and several species of Ribes. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on Ribes. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to Ribes where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves re-infect other Ribes throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on Ribes leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to Ribes to continue the cycle. Although blister rust may spread hundreds of miles from pines to Ribes, its spread from Ribes back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers (these are called **lethal** cankers). Bole cankers result in girdling and death of the tree above the canker. Cankers whose closest margins are more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result (these are called **non-lethal** cankers).

Environmental conditions are critical for successful infection and limit the disease in most years. Moisture and low temperatures favor infection of both hosts, and must coincide with spore dispersal for infection to occur. In California, these conditions occur only infrequently, usually in cool moist sites such as stream bottoms or around meadows. In so called "wave years" when favorable conditions occur, high levels of infection can result. Wave years in California have occurred at approximately ten-year intervals in the past. As one moves from sites most favorable for rust to less favorable sites, the frequency of wave years decreases.